Feasibility Study for Irrigation with Recycled Water – Evaluation of Quality Parameters

Proposition 13
Agricultural Feasibility Study Program Grant Proposal

California Department of Water Resources
Office of Water Use Efficiency
1416 Ninth Street, room 338
Sacramento CA 95814
Attention: Marsha Prillwitz 916.651.9674

Submitted by:

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose CA 95118
408.265.2600
contact: Hossein Ashktorab

Consolidated Water Use Efficiency 2002 PSP

Proposal Part One:

A. Project Information Form

1. Applying for (select one):	☐ (a) Prop 13 Urban Water Conservation Capital Outlay Grant ☒ (b) Prop 13 Agricultural Water Conservation Capital Outlay Feasibility Study Grant ☐ (c) DWR Water Use Efficiency Project	
2. Principal applicant (Organization or affiliation):	Santa Clara Valley Water District	
3. Project Title:	Market Size and Processing Requirements for Irrigation with Recycled Water in the Southern Santa Clara Valley	
4. Person authorized to sign and submit proposal:	Name, title	Hossein Ashktorab, Ph.D., Unit Manager, Water Use Efficiency Unit
	Mailing address	
	Telephone	(408) 265-2607, ext. 2291
	Fax.	(408) 978-0156
	E-mail	hashktorab@valleywater.org
5. Contact person (if different):	Name, title.	
	Mailing address.	
	Telephone	
	Fax.	
	E-mail	
6. Funds requested (dollar amount):		$98,600

7. Applicant funds pledged (dollar amount): $102,145

8. Total project costs (dollar amount): **$200,745**

9. Estimated total quantifiable project benefits (dollar amount):
Percentage of benefit to be accrued by applicant:

Percentage of benefit to be accrued by CALFED or others:

10. Estimated annual amount of water to be saved (acre-feet): **0 – 28,000 af**

Estimated total amount of water to be saved (acre-feet):

Over ___ years

Estimated benefits to be realized in terms of water quality, instream flow, other:

11. Duration of project (month/year to month/year): 9/02 – 9/04

12. State Assembly District where the project is to be conducted: 28

13. State Senate District where the project is to be conducted: 15

14. Congressional district(s) where the project is to be conducted: 16

15. County where the project is to be conducted: Santa Clara County

16. Date most recent Urban Water Management Plan submitted to the Department of Water Resources: 2001

DWR WUE Projects: the above entities (a) through (f) or:

- ☐ (g) investor-owned utility
- ☐ (h) non-profit organization
- ☐ (i) tribe
- ☐ (j) university
- ☐ (k) state agency
- ☐ (l) federal agency

18. Project focus:

- ☒ (a) agricultural

☐ (b) urban

19. Project type (select one):
Prop 13 Urban Grant or Prop 13 Agricultural Feasibility Study Grant capital outlay project related to:

☐ (a) implementation of Urban Best Management Practices

☐ (b) implementation of Agricultural Efficient Water Management Practices

☐ (c) implementation of Quantifiable Objectives (include QO number(s)

☒ (d) other (specify)

recycled water irrigation study

DWR WUE Project related to:

☐ (e) implementation of Urban Best Management Practices
☐ (f) implementation of Agricultural Efficient Water Management Practices
☐ (g) implementation of Quantifiable Objectives (include QO number(s))
☐ (h) innovative projects (initial investigation of new technologies, methodologies, approaches, or institutional frameworks)
☐ (i) research or pilot projects
☐ (j) education or public information programs
☐ (k) other (specify)

20. Do the actions in this proposal involve physical changes in land use, or potential future changes in land use?

☐ (a) yes

☒ (b) no

Proposal Part One

Signature Page

By signing below, the official declares the following:

The truthfulness of all representations in the proposal;

The individual signing the form is authorized to submit the proposal on behalf of the applicant; and

The individual signing the form read and understood the conflict of interest and confidentiality section and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant.

Signature	Name and title	Date

Feasibility Study for Irrigation with Recycled Water –
Evaluation of Quality Parameters

Project summary

This proposal seeks funding to study the feasibility of using recycled water for irrigation in the southern Santa Clara Valley. The salt and chemical content of recycled water, left untreated, may or may not degrade water quality in the aquifer and increase the erodibility of the Valley soils. This study will determine the efficacy of the soil in degrading chemicals of concern, and will determine the relationship between the water's sodium concentration and soil erodibility. The information obtained in the first part of the study will reveal the extent and nature of water treatment that may be required. Information from the second part will likewise elucidate treatment requirements, and will also identify soils which should not be irrigated with recycled water. The combination of treatment requirements and potentially irrigable area will determine the feasibility of the capital investment required to use this water.

A. Scope of Work

A1. Nature, scope and objective

This project's objective is to assess the feasibility of substituting recycled water for imported Central Valley Project water for irrigation in the southern Santa Clara Valley. On average, 28,000 AFY of agricultural withdrawals occur, and 29,000 AFY of CVP water are used to recharge the Valley's Llagas aquifer. The portion of this recharge that can be replaced with surface delivery of recycled water will be determined by recycled water's impact on the aquifer's water quality, on the increase in erodibility of the Valley's soils caused by that water, and by the cost of treatment.

The part of this project dealing with chemicals of concern (COCs) will analyze samples of drainage water from below the root zones of crops that are irrigated with recycled water for anthropogenic chemical compounds. These results will enable us to estimate the chemical impacts that may possibly result from irrigation, and partially determine the extent of advanced treatment that will be required.

The sodium content of recycled water is expected to increase soil loss and runoff from Valley soils when that water is used for irrigation. This project proposes to conduct determinations of erodibility and runoff effects of recycled water on important soils in the Valley. Results will enable the Water District to optimize the combination of recycled water quality and the soils which it will be permissible to irrigate with recycled water.

The limiting concentration of salts in recycled water and the transformation of chemical compounds in the soil are the defining parameters which will determine the feasibility of using recycled water for agricultural irrigation in the southern Santa Clara Valley. The results of these investigations will enable us to estimate the treatment requirements and determine the area of soils we can permissibly irrigate with a given quality of reclaimed water.

A2. Statement of issues

Agricultural and M&I withdrawals from the Llagas aquifer average 47,000 AFY. This is more than twice the average natural groundwater yield, and the difference is made up by recharge with water transferred from the Central Valley Project. The Santa Clara Valley Water District's long term plans suggest it would be feasible to reserve the Llagas aquifer exclusively for M&I consumption. The resulting shortfall in irrigation supplies might then be made up by imports of recycled water.

Surface delivery of recycled water to agricultural and large landscape irrigators in the southern Valley will require an extensive pipeline network. The extent of degradation in the soil of the COCs contained in recycled water will partially determine processing requirements. The amount of land potentially irrigable with recycled water will depend on the water's salt concentration and on the susceptibility of soils to increases in erosion. This study will investigate these constraints, which will determine the feasibility of using recycled water.

The Llagas aquifer is unique among aquifers in California where recycled water is being used in that its water quality is very good. The Santa Clara Valley Water District is committed to maintaining this quality, and this is a constraint of as yet undetermined cost consequences.

Chemical fate during irrigation. Nitrate, organic carbon, disinfection by-products, endocrine disruptors and pharmaceutically active compounds may be present in recycled water. The SCVWD has recently analyzed local recycled water for a comprehensive list of potential COCs. Preliminary results indicate that elevated concentrations of n-nitrosodimethylamine, trihalomethanes, and low levels of lindane, and estrone may be present. The presence of pharmaceuticals is being investigated. To date, the fate of these compounds in the subsurface upon irrigation with recycled water has not been investigated in Santa Clara County.

Researchers from academic institutions in Arizona, Colorado, and California have teamed with the Los Angeles County Sanitation Districts and others to investigate the effect of infiltration on chemical degradation during ponding scenarios with recycled water (soil aquifer treatment). Field sites in Arizona and southern California have been monitored to evaluate the fate of chemicals in secondary and tertiary treated recycled water during groundwater recharge. These studies indicate that the majority of COCs in recycled water may degrade as the water passes through the soil column during infiltration.

While the results of these studies are informative, chemical fate during ponding versus irrigation operations may differ significantly. Ponding involves rapid, high volume infiltration with little evapotranspiration, while irrigation involves repeated, low intensity applications in which most of the applied water evapotranspires and only a fraction leaches past the root zone. COCs are likely to be concentrated in the leachate during irrigation, while this concentration does not occur during ponding. However, it is possible that the degradation of COCs is greater during irrigation because the contact time between the water and upper soil horizon, where most biodegradation is expected to occur, is longer, and aerobic conditions likely dominate.

Data supporting these theories are unavailable; few studies of the fate of chemicals during irrigation have been performed. The result is that, despite the widespread use of tertiary treated recycled water

for irrigation, little is known about the potential impacts to groundwater quality. The SCVWD believes investigations focused on conditions specific to Santa Clara County are needed to enable an assessment of the potential for soil treatment during irrigation in the County. Those chemicals that cannot be adequately treated shall be identified, and the need for additional treatment of the water to remove these chemicals shall be evaluated.

Soil erosion. The southern Valley and its aquifer are part of the Pajaro River watershed, which drains to Monterey Bay. The Pajaro and Llagas Creek, a tributary, are nutrient impacted, and are priority listed for TMDL development for nutrients and sediment. Import substitution with recycled water has to account for potential impacts on the river and on Monterey Bay. The most obvious of these is sediment discharge.

The salt concentration of local recycled water is approximately 700 mg/liter, and that of the aquifer about 400 mg/liter. The difference is largely composed of sodium and chloride. Elevated sodium levels are detrimental to soil structural stability and to erodibility and infiltration rates. Erodibility increases proportionally to exchangeable sodium levels. Runoff volume frequently increases as well in proportion to the percentage of exchangeable sodium.

There are 14,000 acres under irrigation in this branch of the watershed. Doubling of the sediment load is possible with increases in exchangeable sodium that are within common agricultural production parameters. Levels of exchangeable sodium at the upper limit of crop production are noted locally where reclaimed water is in use. Increases of this magnitude are sufficient to increase variability in stream flow because of increases in runoff. Soil loss from the Valley caused by reclaimed water irrigation may be insignificant from a soil conservation standpoint, but may still be significant from the standpoint of water quality. Soils may be excluded from using reclaimed water because of susceptibility to increases in erodibility.

Current general plans maintain the Valley's agricultural base at least through 2020. Agriculture in the county is forecasted to shift toward permanent crops and move onto the hillsides as residential development proceeds on the Valley floor. State regulations specify parallel plumbing and recycled water use in large housing developments. Thus it may not be the case that present water quality problems will be reduced by eventual urbanization.

B. Merit, feasibility, monitoring and assessment

B1. Methods, procedures and facilities

a. Soil treatment. The potential for COCs in recycled water to degrade in soil upon irrigation shall be investigated through a field investigation in which soil water beneath two plots irrigated with recycled water shall be sampled and analyzed. Approximately 10 samples from each plot shall be analyzed. The majority of samples will be collected in the upper three feel of soil, but samples may potentially be collected at locations within the deeper vadose zone, and in groundwater as well, depending upon the rate of movement of the infiltrating water and the feasibility of collecting samples of sufficient volume. The SCVWD is in the process of sampling and analyzing local recycled water for a comprehensive list of potential COCs. Chemicals identified as being present in recycled water, including pesticides, endocrine disruptors, pharmaceuticals, and disinfection byproducts, shall be chosen for analysis in

samples collected beneath the irrigation plots. The chemicals will be qualitatively analyzed. Analyses will be performed by a combination of SCVWD laboratory and outside contractors.

Prior to irrigation, baseline conditions shall be established by sampling and analyzing groundwater from beneath the field plots. Intermittent irrigation (i.e., irrigation for a set period of time followed by a set period of drying) with recycled water shall proceed for several months. Stainless steel lysimeters or another type of lysimeter with little chemical adsorption capacity shall be used to collect the samples. If necessary, several samples collected from the same depth interval may be combined into one composite sample of sufficient volume for chemical analysis. Depending upon soil conditions and irrigation rates, applied water may not reach groundwater during the duration of this experiment; however, most chemical degradation is expected to occur in the shallow soil profile (upper 6 feet), and samples from this region are anticipated to be available. Groundwater beneath the sites may potentially continue to be monitored past the life of this proposed project for signs of impact from applied irrigation with recycled water.

b. Soil erodibility. Plots approximating half the USDA unit soil erosion plot will be sprinkler irrigated over a summer with well water and two strengths of recycled water. Soils will be selected on the basis of their total area in the Valley and their proximity to watercourses. Background levels of bulk density, aggregate stability, exchange capacity and exchangeable sodium will be measured. These will again be measured at the end of the season's irrigation. Plots will be disced in late summer, and their erodibility evaluated with a rainfall simulator. Some plots will be monitored for sediment loss through the winter rains. Plot layout, irrigation and cultivation will be done by SCVWD. Erodibility studies will be contracted out to the Department of Land, Air and Water Resources at U.C. Davis.

B2. Project task list and schedule

Please refer to attachments to this proposal for the project schedule.

C. Qualifications of applicants and cooperators

C1. Resumes of project managers

Please see attachments for a complete list of resumes of key program personnel.

C2. Roles of external cooperators

a. Soil treatment – External cooperators will function as contractors to carry out chemical analyses of the soil solution samples.

b. Soil erodibility – Cooperator will be U.C. Davis School of Land, Air and Water Resources, under the direction of Dr. Michael Singer. They will carry out the soil erodibility studies.

D. Benefits and costs

D1. Budget breakdown and justification

Please see attachment for a detailed budget.

D2. Cost sharing – $65,472 and $36,672 are to be contributed by the Santa Clara Valley Water District for the analysis of chemicals in drainage waters and for the erosion studies, respectively.

D3. Benefit summary and information to be gained, agricultural

a. This study's results will provide information about the processing requirements that may be necessary for the use of recycled water for irrigation, and about the extent of land area in the Valley that will be irrigable with recycled water. Estimated unit treatment costs may be optimized on irrigable area. This information will be the basis for investment decisions related to the size of treatment plants, the intensity of processing and the extent of pipeline networks. Additionally, the results will inform estimates of the feasible amount of recycled water substitution of CVP imports.

Recycled water is a comparatively reliable source, and may provide some amount of import substitution, conceivably up to 28,000 AFY. More important is the doubling in water use efficiency that results from reuse. To a degree, recycled water use will relieve both growers and water retailers from the uncertainty inherent in reliance on imported water supplies; the former directly, the latter by making a larger share of the aquifer available for potable supplies.

This study will provide a quantitative assessment of the potential of recycled water to degrade the environment, and so provide a basis for the accommodations which will be necessary to use recycled water safely.

b. Cost comparison. This study will provide a basis for capital investment in treatment plants and pipelines. Additionally, this study investigates the processing levels necessary to avoid impacts on a local aquifer and a national marine sanctuary. The processing and pipeline installation costs dwarf the amount requested.

The value of imported water saved for other uses, from the standpoint of Santa Clara County, at this time is probably about $20 per acre foot annually. This is the sum of pumping and CVP Improvement Act contributions. When put in terms of the water's capacity to fuel growth, and to provide future employment and tax revenues, the costs of the study are again comparatively small.

E. Outreach, community involvement and acceptance

The Santa Clara Valley Water District is in the process of holding economic sector focus groups on the issues of recycled water use. Focus groups have been held for agriculture, large landscape, environmental and industrial sectors. Additional focus groups are to be held throughout this year to present plans and receive feedback. Generally, the groups look upon recycled water as an unexploited resource. There are concerns about using the water for environmental enhancement purposes, and the District hosts an endocrine disrupting chemicals working group to address this aspect of using recycled water for environmental and industrial purposes. The feasibility study results will be incorporated in succeeding rounds of focus groups.

The information gained by this study on the effects on COCs of their concentration by evapotranspiration and of lengthened residence time in the soil will be made available in a publication. Similarly, results on the relationship between exchangeable sodium levels and soil properties will also be published.

B2. Project task list and schedule

soil treatment studies

TASKS:	Q4/2002	Q1/2003	Q2/2003	Q3/2003	Q4/2003	Q1/2004	Q2/2004	Q3/2004
Identify plot locations	$5,563							
Create plots, sample systems		$8,131						
Purchase and set soil solution sampling tubes		$8,707						
Sample background soil solution levels		$9,414						
Background sample analyses		$29,000						
Soil solution sampling			$4,707	$4,707				
Sample analyses				$29,000				
Data recording and analysis					$13,694			
Final report *						$14,549		
quarterly sums:	$5,563	$55,252	$4,707	$33,707	$13,694	$14,549		
annual costs:	$5,563				$107,360	$14,549		

soil erosion studies [1]

TASKS:	Q4/2002	Q1/2003	Q2/2003	Q3/2003	Q4/2003	Q1/2004	Q2/2004	Q3/2004
Identify plot locations	$3,914							
Establish plots and install drag line sprinkler system		$4,609						
Establish parameter values		$10,800						
Mow and irrigate plots			$9,019	$9,019				
Erodibility studies				$13,000				
Establish post treatment parameter values					$10,800			
Winter erosion studies					$3,914	$3,914		
Data analysis							$2,000	
Report preparation *								$2,283
quarterly sums:	$3,914	$15,409	$9,019	$22,019	$14,714	$3,914	$2,000	$2,283
annual costs:	$3,914				$61,161			$8,197

* indicates deliverable; due end of quarter

[1] headings delineate separable sections of feasibility study

D1. Budget breakdown

			Raw Labor Hourly Rate	Note (a) FY 1999-00 OMB A-87 Overhead 106.03%	Total Hourly Labor	Hours	Labor Expenses	Equipment Expenses	Contract Services	Total Costs	SCVWD Contribution	Grant Request
	Soil treatment	**Classification**										
Tasks	Identify plot locations	Assoc. Civil Engineer	$ 41.54	$ 44.04	$ 85.58	65	$ 5,563			$ 5,563	$ 5,563	
	Create plots, sample irrigation systems	Assoc. Civil Engineer	$ 41.54	$ 44.04	$ 85.58	95	$ 8,131			$ 8,131	$ 8,131	
	Purchase and set soil solution sampling tubes	Assoc. Civil Engineer	$ 41.54	$ 44.04	$ 85.58	55	$ 4,707	$ 4,000		$ 8,707	$ 4,707	$ 4,000
	Sample background soil solution levels	Assoc. Civil Engineer	$ 41.54	$ 44.04	$ 85.58	110	$ 9,414			$ 9,414	$ 9,414	
	Background sample analyses	Contract out							$ 29,000	$ 29,000		$ 29,000
	Soil solution sampling	Assoc. Civil Engineer	$ 41.54	$ 44.04	$ 85.58	110	$ 9,414			$ 9,414	$ 9,414	
	Sample analyses	Contract out							$ 29,000	$ 29,000		$ 29,000
	Data recording and analysis	Assoc. Civil Engineer	$ 41.54	$ 44.04	$ 85.58	160	$ 13,694			$ 13,694	$ 13,694	
	Final report	Assoc. Civil Engineer	$ 41.54	$ 44.04	$ 85.58	170	$ 14,549			$ 14,549	$ 14,549	
	Total Expenses					**765**	**$ 65,472**	**$ 4,000**	**$ 58,000**	**$ 127,472**	**$ 65,472**	**$ 62,000**

			Raw Labor Hourly Rate	FY 1999-00 OMB A-87 Overhead 106.03%	Total Hourly Labor	Hours	Labor Expenses	Equipment Expenses	Contract Services	Total Costs	SCVWD Contribution	Grant Request
	Soil erosion studies	**Classification**										
Tasks	Identify plot locations	Ass't. Civil Engineer	$ 31.66	$ 33.57	$ 65.23	60	$ 3,914			$ 3,914	$ 3,914	
	Establish plots and install drag line sprinkler system	Ass't. Civil Engineer	$ 31.66	$ 33.57	$ 65.23	40	$ 2,609	$ 2,000		$ 4,609	$ 4,609	
	Establish parameter values	Contract out							$ 10,800	$ 10,800		$ 10,800
	Mow and irrigate plots	Equipment Operators	$ 22.40	$ 23.75	$ 46.15	250	$ 11,538	$ 6,500		$ 18,038	$ 18,038	
	Erodibility studies	Contract out							$ 13,000	$ 13,000		$ 13,000
	Establish post treatment parameter values	Contract out							$ 10,800	$ 10,800		$ 10,800
	Winter erosion studies	Ass't. Civil Engineer	$ 31.66	$ 33.57	$ 65.23	120	$ 7,828			$ 7,828	$ 7,828	
	Data analysis	Contract out							$ 2,000	$ 2,000		$ 2,000
	Report preparation	Ass't. Civil Engineer	$ 31.66	$ 33.57	$ 65.23	35	$ 2,283			$ 2,283	$ 2,283	
	Total Expenses					**505**	**$ 28,172**	**$ 8,500**	**$ 36,600**	**$ 73,272**	**$ 36,672**	**$ 36,600**
	Grand Total									**$ 200,745**	**$ 102,145**	**$ 98,600**

Note (a) FY 1999-2000 Fringe Benefits and overhead based on SCVWD's Federal Office of Management and Budget Circular A-87 Overhead Rate (106.03%).
Will apply current rate for actual claim.

CINDY S. KAO, Ph.D., P.E.

Education

- Degrees:
  University of California, Berkeley, B.S. in Civil Engineering *(1990 with high honors)*
  University of California, Berkeley, M.S. in Geotechnical Engineering *(1991)*
  University of California, Berkeley, Ph.D. in Civil and Environmental Engineering *(1996)*
- Honors/Fellowship:
  Graduate Mentorship Fellowship, *University of California at Berkeley (1990-1992)*
  Environmental Restoration and Waste Management Fellowship, s*ponsored by the United States Department of Energy (1992-1995)*

Professional Experience

Associate Civil Engineer – Water Use Efficiency Unit
Santa Clara Valley Water District, San Jose, California (November 2001to present)
Responsible for assisting in the development of the District's water recycling programs with emphasis on understanding and preventing potential impacts to groundwater quality from recycled water applications. Duties include studying issues related to disinfection by-products, salinity, and emerging contaminants such as endocrine disruptors and pharmaceuticals and their relevance to potential uses of recycled water (e.g., irrigation, streamflow augmentation, wetland mitigation, groundwater recharge).

Associate Civil Engineer – Leaking Underground Storage Tank Oversight Program
Santa Clara Valley Water District, San Jose, California (July 1999 to April 2001)
Responsibilities include supervision of caseworkers, providing assistance with recruitment efforts of the District and the Unit, review of solvent cases, bulk fuel terminals, above-ground storage tanks, and oversight of fuel leak cases in Santa Clara County.

Environmental Engineer.
Erler & Kalinowski, Inc., San Mateo, California (May 1997 to July 1999)
Experience includes performing and evaluating human health risk assessments, evaluating soil and groundwater contamination from historic sources at the Presidio of San Francisco and Fort Baker, evaluating subsurface contaminant transport at various brownfield sites using numerical models, and evaluating groundwater contamination from underground storage tank sites.

Assistant Professor
Department of Civil and Environmental Engineering, Worcester Polytechnic Institute, Worcester, Massachusetts (August 1996 to May 1997)
Responsibilities included performing research in contaminant transport and geohydrology and teaching undergraduate courses in earth structures and geology.

Research Experience

Graduate Research Assistant

University of California at Berkeley (1991 - 1992)

Investigation of moisture, heat, and radioisotope transport in unsaturated soils using field data collected from the Nevada Test Site.

Environmental Restoration and Waste Management Fellow

Lawrence Livermore National Laboratory (1993)

Field study and mapping of fractured alluvium at the Nevada Test Site

Doctoral Student

University of California at Berkeley (1992-1996)

Development and experimental investigation of a wetting front model for infiltration into soils.

Assistant Professor

Worcester Polytechnic Institute (August 1996 - May 1997)

Prepared research proposals and oversaw the experimental research of a Master's student.

Publications

C.S. Kao and J. R. Hunt, A plug flow model of liquid infiltration into dry soils, *American Geophysical Union Hydrology Days Conference Proceedings, Colorado State University (1994), 183-193.*

C. S. Kao, D. K. Smith, and W. B. McKinnis, New observations of infiltration through fractured alluvium in Yucca Flat, Nevada Test Site: a preliminary field investigation, *Lawrence Livermore Laboratory Report UCRL-ID-116129, (1994), 41 p.*

C. S. Kao and J. R. Hunt, Prediction of wetting front movement during one-dimensional infiltration into soils, *Water Resources Research Vol. 32, No. 1 (1996), 55-64.*

C. S. Kao and J. R. Hunt, Experimental validation and applications of a fluid infiltration model, *Journal of Environmental Engineering, Vol.127, No. 2 (2001), pp. 162-169.*

ROBERT SIEGFRIED

EDUCATION

University of California – Berkeley
Graduate study in geostatistics and geographic information systems

Naval Postgraduate School – Monterey
Classes in linear algebra, differential equations, vector calculus and complex variables

University of California – Davis
Master of Science, soil science

California State University – Fresno
Undergraduate and graduate study in viticulture and soil science

University of Washington
Graduate study in Chinese history and language

California State University – Fresno
Bachelor of Arts, history

PUBLICATIONS, CITATIONS and ACKNOWLEDGEMENTS

"The Extraneous Matter in Mechanically Harvested Wine Grapes," American Journal of Enology and Viticulture, 27:1, 1976.

Weaver, Robert J., Grape Growing, John Wiley and Sons, New York, 1976.

USDA – Economic Research Service, Production Costs and Consumer Acceptance of Dried-on-the-Vine Raisins, Agricultural Economic Report No. 337.

Petrucci, V.E., A Treatise on Raisin Production, Processing and Marketing, Malcolm Media, Clovis, 2002 (in press).

PROFESSIONAL EXPERIENCE

SANTA CLARA VALLEY WATER DISTRICT

Assistant Civil Engineer – Agricultural. Supervise irrigation management mobile laboratory. Work with growers to solve problems related to irrigation with tertiary treated recycled water.

RH PHILLIPS VINEYARDS, Inc.
Esparto, California

Viticulturist. Introduced restricted irrigation, shoot thinning, spot reduction of lime induced chlorosis, a systematic method of evaluation of fields for pruning and the spatial referencing of wine lots on a GIS. Diagnosed nematode infestations and carbohydrate deficiency. Conducted trials in cropping levels, irrigation, potassium fertilization, pruning and the optimization of crop exposure. Selected a site for a new vineyard that has now been planted. Initiated county wide *Xyllela fastidiosa* survey.

LANDELL MILLS ASSOCIATES, LTD.
Bath, U.K.

Raisin Production Specialist. Consulting viticulturist to the Afghan Dried Fruit and Raisin Institute for the World Bank's Afghan Fruit and Vegetable Export Project. Taught raisin production and established demonstration plots. Assisted the Afghan Agricultural Development Bank in developing a repayment schedule for loans for trellising.

UNIVERSITY OF CALIFORNIA, DEPARTMENT
of LAND, AIR and WATER RESOURCES
Davis, California

Staff Research Associate. Operated a research project in vineyard irrigation at the University's West Side Field Station to determine the leaching fraction necessary for irrigation with saline water. Trained the vineyard, irrigated and maintained a water budget with an in-field lysimeter, neutron probe and tensiometers.

CALIFORNIA STATE UNIVERSITY – FRESNO,
VITICULTURE and ENOLOGY RESEARCH CENTER
Fresno, California

Research Coordinator. Supervised and conducted research in mechanical grape harvesting, in-field grape crushing, raisin harvest mechanization and drip irrigation. Performed statistical analyses, and prepared and presented reports to sponsoring institutions, among which were the State Board of Food and Agriculture and the California Raisin Advisory Board.

HOSSEIN ASHKTORAB

EDUCATION:

Ph.D., University of California, Davis, 1989. Plant, Soil and Water Science.
Master of Science, California State University, Chico, 1981. Irrigation
Bachelor of Science, University of Mazandaran, 1979. Agriculture Engineering.

PROFESIONAL EXPERIENCE:

***Unit Manager*, Water Use Efficiency Unit, Santa Clara Valley Water District, Jan. 2001 – Present**
Responsible for managing the District Water Use Efficiency Unit (WUE) providing technical direction, coordinating its activities with other District Units, and external stakeholders including 13 water retailers. The water conservation program is a long-term commitment of the District, which provides the highest quality programs and educational opportunities to residents and businesses in Santa Clara County.

Managing the implementation of all 14 BMPs required by the Memorandum of Understanding Regarding Urban Water Conservation in California (MOU). In addition, Managing the adopted Water Conservation Plan (including agriculture water conservation program) to comply with US Bureau of Reclamation mandate as required by the Central Valley Project Improvement Act (CVPIA).

Manage and participate in the development, implementation and administration of the water conservation and water recycling programs with more than $9 million annual budget in Santa Clara County.

Develop partnership with local and regional cities including various water conservation programs with City of San Jose with more than $3 million cost-sharing budget as well as cost-sharing agreement with six other agencies in Northern California for residential efficient clothes washing machine.

Participate and engage in the recycled water partnership such as South Bay Water Recycling cost sharing agreement for the amount of $50 million projects in the Santa Clara County.

Participate and coordinate with local, regional and statewide water conservation and recycling organizations. Member of CUWA water conservation committee and CUWCC steering, plenary, Program committees and several subcommittees.

***Water Conservation Specialist*, Water Use Efficiency Unit, Santa Clara Valley Water District, 1/97 to 1/01**
Developed and managed water conservation programs including programs for agricultural and large landscape water users.

Technical staff to District Landscape Water Advisory Committee and the District Agriculture Water Advisory Committee.

Responsible for implementation of CALFED grants for the District Agricultural and Urban Water Use efficiency programs. Developed proposals and received grant fund for two District's water recycling projects from Propostion-13 grant funding.

In partnership with the Santa Clara Farm Bureau, UC Cooperation Extension, Department of Agriculture, Department of Water Resources, and Santa Clara County Natural Resource Conservation Service, Developed and conducted nine Agricultural Irrigation and Nutrient Management seminars for the County growers and interested groups

***Associate Land Water Use Analyst*, California Department of Water Resources, 12/86 to 9/83**
Technical coordinator for the Assembly Bill 325 Task Force Advisory Committee in 1991 and 1992 and facilitated the development of the State Landscape Water Conservation Model Ordinance. Assisted water agencies, cities and counties to develop and implement landscape water conservation guidelines and ordinances.

As a member of the State Water Conservation Advisory Committee, participated in the development of the Best Management Practices (BMPs) in water conservation.

Participated in the negotiation with the agricultural stakeholders and U.S. Bureau of Reclamation for the State Department of Water Resources Drought Water Bank. Developed a new method using nonlinear regression model to estimate crop water requirement values for major crops in the Delta's agricultural area which was the bases for the negotiation of the irrigation water use.

Supported agencies in the development of their water management plan, implementation and evaluation of various water conservation programs such as the ULF toilet replacement, toilet displacement devices, low flow shower heads and outdoor water audits.

Member of the 1989 and 1992 Xeriscape Conferences Steering Committee and chaired the Award Subcommittee meetings.

***Irrigation Consultant*, Chico, California, 2/80 to 9/81**
Designed irrigation system and developed irrigation management plan for various farmers including a large fruit orchard located in Chico.

RESEARCH AND TEACHING EXPERIENCE:

***Assistant Professor*, Dept. of Irrigation Eng., Shiraz University, 9/93 to 6/96**
Lectured on urban water use and conservation, crop water requirements, evapotranspiration and irrigation systems and design. Directed related laboratories and field trips.

***Research Assistant professor,* University of California, Davis, 6/96 to 12/97**
Crop water requirement and water management. 3-D Aerodynamic latent heat flux research studies. Field research study on irrigation system and evaluation.

***Research Assistant,* University of California, Davis, 9/81 to 5/82 & 4/83 to 12/86**
Field laboratory investigations related to the separation of soil evaporation and transpiration of tomato plants. Studied the evaporation rate under different plant growth stages and soil moisture contents using highly sensitive Lysimeter. Collected and interpreted weather station data at U.C. Davis field station. Worked extensively with instruments, soil moisture and particle size analysis. Engaged in field and greenhouse studies related to root elongation, density, and plant response under different drip irrigation regimes and fertilizer applications.

CERTIFICATION:
Irrigation Systems Evaluation; Landscape Irrigation Master Auditor

PROFESSIONAL MEMBERSHIP:
American Society of Civil Engineers**;** Irrigation Association**;** American Water Works Association; WateReuse Association**.**